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FISHERIES OF THE SOUTHERN BEAUFORT
SEA AND MACKENZIE DELTA:
IMPACTS OF DEVELOPMENT

EVIDENCE OF
JEFFREY N. STEIN

MACKENZIE VALLEY PIPELINE INQUIRY

C.O.P.E. DELTA PHASE

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Fisheries and Marine Service, Western Region, initiated studies of the Mackenzie Delta as part of the Environmental-Social Committee's Mackenzie Valley Pipeline Program. From a base camp, located in Aklavik between 1972 and 1974, field crews examined the fish resources over much of the southern reaches of the Delta, the main objectives being to:

- 1) Define the biology and life histories of the major fish species including age composition, growth rates, species composition, distribution and food habits.
- 2) Determine the timing of fish migrations and the major migratory routes used.
- 3) Locate and define critical habitat areas including areas utilized for spawning, rearing, feeding and overwintering purposes.
- 4) Identify areas normally fished domestically and obtain an estimate of the quantities of fish taken.

Project results have been presented in a series of reports to the Environmental-Social Committee and are listed in an Appendix to this statement.

During 1974, a study of the anadromous and freshwater fish of the outer Mackenzie Delta was initiated under the auspices of the Beaufort Sea Project. In addition to expanding on the objectives given previously, the Beaufort Sea Study also attempted to:

- 1) Establish the seasonal and geographic sensitivity of the fish resource, and
- 2) Examine lagoons subject to inundation from the Beaufort Sea and ascertain their role in the life history of major species.

A series of approximately 75 locations were sampled during the field season. Four of these were considered as monitoring sites and were sampled once a week. Results of

the Beaufort Sea study have been presented in two reports by Percy and others (1974, Beaufort Sea Project B-2) and Percy (1976, Beaufort Sea Project Technical Report No. 8). Additional Fisheries projects conducted under the Beaufort Sea Program included: studies of the Yukon coastal region by Kendel and others (1976, Beaufort Sea Project Technical Report No. 6); and an investigation of the eastern Beaufort Sea by Galbraith and Hunter (1976, Beaufort Sea Project Technical Report No. 7).

Deltas in general represent some of the most productive ecological systems in the world. They represent important habitats wherever they occur but are especially important in the north where alternative productive habitat often does not exist in the surrounding region. In the case of the Mackenzie Delta, many of the freshwater species of the southern Beaufort Sea and Mackenzie River system depend on the delta. Several marine species also frequent the outer Delta.

Freshwater fish populations in the Delta region can be placed in one of two rather general categories. The first of these, anadromous fish, includes such species as humpback and broad whitefish, Arctic and least cisco, inconnu and Arctic char which spend much of their life cycles in brackish or marine waters while migrating into fresh water to spawn or over winter. These spawning migrations may begin as early as late July with the adults usually completing the return migration by November. While some species, such as inconnu or Arctic cisco, appear to migrate as far upstream as Norman Wells, others, such as broad and humpback whitefish, apparently utilize back eddies of the Mackenzie River, the Delta itself, or more southerly tributaries such as the Arctic Red and Peel Rivers.

The second category might be called resident species or populations which spend their entire life cycle in freshwater and are only rarely encountered in the marine

environment. This group includes such species as northern pike, Arctic grayling and suckers. Although migrations may be made, the spawning habitats are usually local.

Marine species, such as the saffron cod, starry flounder and Arctic flounder normally reside in salt water. However they are frequently found in the brackish water of the in-shore Delta, presumably to feed. Additional species are also found farther offshore with Arctic cod being most abundant.

The Delta region provides essential habitat for a multitude of fish species. The Beaufort Sea study alone identified at least 19 species of freshwater fish and 4 marine species inhabiting the outer Delta. Some species such as the Arctic cisco, feed heavily during the spring and early summer months prior to beginning spawning migrations. Once migration begins, it appears that feeding essentially ceases until the completion of spawning. Of course certain areas of the Delta and Beaufort Sea seem to be more important than others for feeding purposes. This is especially true of coastal lagoons or lakes having outlets to Delta channels or the sea. Clear deep lakes on the other hand, are primarily used by lake trout and least cisco. Coastal lagoons also appear to be important nursery areas for anadromous species, the juveniles having moved down from spawning areas during the spring freshet.

Although spawning is known to occur within the Delta itself, few specific areas have been identified. Resident populations probably make use of smaller lakes and channels or streams such as Holmes Creek. Populations of humpback and broad whitefish are thought to make use of backeddies within the Delta or the Mackenzie River itself. However, for most migratory populations the Delta serves only as a migration route to upstream spawning areas.

Much of the Delta and inshore Beaufort Sea also provide overwintering habitat for marine, resident and migratory



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populations. Lakes and channels with sufficient depth are utilized by whitefish, least cisco and lake trout. Least cisco, Arctic cisco, Arctic flounder, burbot, boreal smelt, inconnu and fourhorn sculpins overwinter in Mallik Bay. Areas suitable for overwintering are also plentiful along the northeast coast of Richards Island. Relatively small numbers of boreal smelt, humpback whitefish and least cisco have been netted through the ice in Kugmallit Bay, but this is probably a reflection of low fishing effort in winter. Inconnu and fourhorn sculpin have also been captured in the Shingle Point area, west of the Delta in winter.

Because of the abundant and diversified habitats available, the abundance of the fish resource itself and the use made of that resource, the Mackenzie Delta has been designated by Fisheries and Marine Service as an area likely to be sensitive to pipeline construction. There are several aspects of pipelining which are expected to adversely affect the aquatic resources. These include gravel removal, water use, increased sedimentation, road construction, increased fishing pressure and the use of methanol for pipeline testing. In previous testimony before this commission, I discussed these concerns in some detail and provided recommendations which, in my opinion; will reduce adverse effects to acceptable levels. These appear in Volume 103 of the Proceedings Pages 15720 - 15743. I only wish to point out here that these concerns and recommendations are equally applicable, if not more so, to the Delta region as to the rest of the Mackenzie Valley.

However, there are other development plans which could result in greater disruption to the resource than that associated with normal pipelining activities. Dredging for instance is proposed for the construction of major Delta channel crossings, and may also be required for development of medium draft harbour facilities for drill ships or to improve access to wharf and stockpile sites. Although such

operations are normally of concern because of the environmental effects of increased levels of suspended sediment they are of particular concern in an area inhabited by so many migratory fish populations. Dredging operations will likely be conducted during periods of mass fish migration but, in my opinion, we do not possess the predictive capability to speculate on how these migrations will react to multifold increases in normal suspended sediment levels, the mechanical noises of the dredging operation itself or to changes in flow patterns either over the spoil pile or around berms constructed to facilitate dredging. These concerns could be mitigated by timing dredging operations to avoid critical migration periods. However care must also be taken to avoid interference with other resources such as the beluga whale.

Seismic exploration in the Delta and Beaufort Sea region has increased sharply over the past few years and can be expected to continue for some time to come. Such techniques will be used to delineate gas and oil fields, determine the extent of permafrost layers and ascertain where abnormal pressures may be encountered. Unfortunately, there is limited information available on how such techniques affect northern fish species. High explosives as well as air guns are currently in use and while the former provides the best geological information it is also the more destructive to the fish resource, including all the domestically and commercially important species. Mortality especially results with those species with gas bladders since they are unable to adjust to rapid pressure changes. Until better information is available, we can only recommend that seismic operations avoid known critical habitat areas and be conducted during times considered least sensitive to the resource.

The potential for disruption of aquatic environments can be expected to increase significantly during the exploratory drilling phase of Delta development. One area of concern is the disposal of wastes at the drilling fluids which are used in large quantities to equalize hydrostatic pressures, to remove drill cuttings and to lubricate the drill bit. They usually consist of a water-clay mixture although many chemicals are added to the muds for viscosity improvement, pH adjustment, anti-corrosive properties, weight and a host of other desirable factors for drilling.

Drilling fluids from the Mackenzie Delta and nearshore Beaufort Sea have been shown in a number of studies to be acutely toxic to fish in freshwater (Falk and Lawrence, 1973; Logan et al., 1973) and more recently to both fish and intertidal invertebrates in marine waters (B.C. Research Ltd., 1975). In normal land-based drilling, drilling fluids, brines and cuttings along with "house-keeping wastes" are contained for extended periods in earthen sumps and treated to render them innocuous. However, this procedure will not be feasible in offshore drilling where space will be a limiting factor. Since the composition of drilling fluids varies widely from well to well and within a single well, the toxicity to aquatic fauna is also quite variable. It is imperative therefore that there be stringent waste water and drilling fluid disposal regulations, and enforcement of those regulations.

The most obvious potential threat to the aquatic environment associated with proposed offshore exploration is a massive oil spill. Although fish gills are mucous coated, effectively repelling minute quantities of oil, they are incapable of accommodating a major polluting incident. If gills become oil-coated, respiration and ion exchange are severely limited. This ultimately leads

to death since there is no self-cleaning mechanism. Fish are more likely to come into intimate contact with oil in a dispersed form than with floating slicks; moreover, oil in emulsion appears to adhere to gill tissue more readily (Smith, 1974). Solution of the lighter saturated and aromatic components of oil (also the most toxic to fish) in the water column occurs early in the life of an oil slick. An offshore spill would therefore tend to lose its toxic components before reaching the nearshore zone. However, recent evidence suggests that oil can be incorporated into newly forming ice thus rendering the weathering and biodegradation processes inoperative for extended periods.

Pollutants such as oil, also can cause nervous and gastric disorders in fish. Fish of different species, size and age vary in their resistance to pollutants. Physiological and behavioural changes brought about by pollutants will interfere with the ability of fish to cope with the "normal" stresses in an already harsh environment. There is a definite need to examine sublethal effects of pollutants on aquatic organisms. The presence of even small quantities of petroleum hydrocarbons in the flesh of fish can also produce disagreeable flavour and odours (Smith, 1974). This is an important aspect considering the domestic utilization of the resource in the southern Beaufort Sea.

Most likely however, impact on the fish resource itself resulting from an oil spill will be through large-scale loss of food organisms, probably resulting either from a change in food habits, or emigration from the contaminated area. Sinking readily takes place in estuarine locations since suspended sediments are available as adsorptive nuclei for oil. The benthic flora and fauna upon which many fish species depend may, as a result, be reduced or contaminated for extended periods.

Free oil and emulsions can also coat algae and other plankton causing them to settle to the bottom, out of reach of pelagic fishes.

Any large scale reduction in the aquatic invertebrate fauna would have a profound effect on the fishery. Stomach analysis indicate that fish utilizing the area are largely dependent on this food source. Many of the fish species present tend to be opportunists in their feeding habits and could therefore probably compensate for minor changes. It should be noted that all species are important to the stability of an ecosystem since the more diverse the biological community the greater its ability to compensate for changes in the environment.

Several coastal areas near the Mackenzie Delta contain fish population which may be sensitive to contaminants originating offshore. It appears that many of these lagoons and embayments are not normally flushed by the Mackenzie. Low rates of exchange of water and the occurrence of storm tides therefore render these areas highly susceptible to pollutant contamination from routine exploration activities or to oil from an uncontrolled well blowout.

Areas sensitive to disruption are found along the west coast of Tuktoyaktuk Peninsula, the irregular northeast shoreline of Richards Island between Pullen and Hendrickson Islands, the Mallik Bay area on the north shore, and the Yukon coast. All contain large populations of adults and fry throughout the summer months (primarily whitefish, ciscos and inconnu). These habitats provide a haven within the Beaufort Sea/Delta area for marine fish species such as flounders, sculpins, pacific herring and saffron cod. Fish also concentrate near Kendall Island (least cisco and burbot) and Garry Island (boreal smelt and ciscos) during the summer. These areas become even more sensitive in fall,

at which time inconnu congregate for overwintering in nearby channels and in Mallik Bay. With the exception of the western and northwestern portion of Shallow Bay; which is a migration corridor for char, inconnu and ciscos, no large fish populations were found in the region between Shallow Bay and Garry Island during our Beaufort Sea investigations.

Should a massive polluting event occur offshore of the delta, it is imperative that the polluting material be prevented from reaching critical inshore habitats. In my opinion mechanical clean-up techniques alone should be used in combating oil spills until we have gained a greater insight into the fate and effects of dispersants and of dispersed oil in the marine environment. Often the emulsifiers that are used in temperate waters prove to be more toxic to fish than the oil being mopped up. Similarly, sinking agents merely transfer the problem from the surface to the bottom where it becomes virtually impossible to deal with. Mechanical clean-up equipment now in use must be radically improved to cope with oil spills at sea and new approaches devised to recover oil on and under ice. It is recommended that during any polluting incident first priority be given to preventing oil or other pollutants from moving into the nearshore zone where contact with estuarine waters will lead to its sedimentation and retention for extended periods of time. Sedimentation of oils and tars along the coast could destroy nursery and spawning areas and may kill essential benthic food organisms or force them to emigrate from the area.

If approval is granted for offshore exploration an essential requirement is a program of effective resource monitoring studies that will facilitate the identification and resolution of potentially dangerous environmental problems at the earliest possible stage. Studies done to date are not adequate to predict the effects of extensive off-

shore drilling and production in the Beaufort Sea. It is important that further studies be carried out prior to such development, during the period of disturbance and during an assessment phase. It is critical to monitor control areas, along-side impacted areas, in order to distinguish natural environmental trends from those changes induced by man. Now that an inventory of baseline data for environmental components in the Beaufort Sea has been compiled, adequate oil clean-up contingency plans can and must be developed. These must not be imported from other less hazardous areas in the south, but developed with the specific environmental problems of the area as a focus.

It is my understanding that baseline hydrocarbon levels in tissues of a few species of plankton, invertebrates and fish as well as for Beaufort Sea water have been determined. The report is not yet available. This program should be expanded to provide reference material for comparison with hydrocarbons found in tissues and water at later dates. This will be particularly useful in determining the persistence of oil in the Arctic aquatic environments. Industry should provide samples of oil discovered in the Beaufort Sea area to allow meaningful site-specific toxicity and behavioral studies to be carried out.

In conclusion, the Mackenzie River Delta provides essential habitat for the maintenance of the freshwater, coastal marine or anadromous fish resources in much of the southern Beaufort Sea area and Lower Mackenzie River. The inshore zone is an important nursery, feeding and overwintering site for both nearshore and offshore organisms. It is especially important to those anadromous species which form the basis of the domestic and commercial fishery in the Delta (broad whitefish, Arctic char, Arctic cisco and inconnu). Standing stocks of fish are

greatest nearshore since the anadromous species tend to frequent shallow coastal waters during the summer months rather than moving far offshore.

Proposed developments in the delta region can be expected to adversely affect aquatic resources. In my opinion, only if industrial developments incorporate environmental design measures, as recommended to this commission, will these effects be minimized.

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A P P E N D I X I I

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